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Description

The present invention relates to a tire uniformity measuring apparatus according to the preamble of claim 1.

5 An apparatus of this kind has become known by US-A-3 375 714 or US-A-3 661 014.

Concerning these prior art apparatuses a movable member has a portion rotatably supporting a shaft of a drum which is in contact with a tire to be measured and driven by this tire. The longitudinal axis of the movable member is arranged at a right angle with regard to the rotation axis of the tire and the rotation axis of the drum.

10 In view of the great mass and in so far of the great inertia of the drum which is supported by the movable member the sensitivity of response is limited and small and quick alterations of forces cannot be detected exactly.

Besides that the accuracy of measurement is affected by a variation of the contact area between the tire and the drum in the circumferential direction, when the movable member swings responsive to a variation of radial forces which have to be detected.

15 US-A-3 780 573 discloses an apparatus and a method for determining wheel/tire uniformity in which the wheel is rotatably mounted on one end of a support shaft and rotated under load against a moving surface. The support shaft is clamped in two spaced apart force-measuring devices each being sensitive in at least two directions which are perpendicular to one another and to the support shaft. The support shaft is held rigidly in position by the two force-measuring devices and the forces exerted to the shaft are detected.

20 In order to keep the support shaft in position and to maintain a fixed interaxial distance between the drum and the tire during uniformity measurement an increased overall rigidity and precision of the apparatus is required.

It is an object of the present invention to provide a tire uniformity measuring apparatus according to the preamble of claim 1 which is able to detect a radial force variation (R.F.V.) on a tire with high sensitivity of response and high precision under a condition approximating an actual running condition. The apparatus shall be light in weight, compact in size and simple in construction.

The apparatus according to the invention is characterized by the features of claim 1.

Advantageous embodiments of the invention are described in the subclaims.

30 With the tire uniformity measuring apparatus thus constructed, the automotive tire being measured is loaded in advance by the load applying means, and the drum is driven to rotate the tire. A displacement of the rotatable shaft produced in response to a variation in the radial force acting between the tire and the drum is detected as a displacement of the movable member which is in turn indicated as the radial force variation generated on the tire. Thus, the apparatus can measure a radial force variation with precision under a condition approximating an actual running condition of automobiles.

35 The tire uniformity measuring apparatus according to the present invention allows the rotatable shaft to which the tire being measured is attached to be displaced slightly in order to detect a reactive force from the shaft as a displacement of the movable member, rather than fixing the interaxial distance between the drum and the tire while revolving under a given load.

40 No measurement at the shaft being rotated is therefore made, a feature different from the conventional apparatus, and hence a force variation corresponding to a radial force variation on the tire can be picked up with utmost ease.

The tire uniformity measuring apparatus according to the present invention is additionally advantageous in that the apparatus is of less overall rigidity than prior apparatus, does not require a sophisticated electrical measurement circuit, is simple in construction, light in weight, compact in size, and inexpensive to construct.

45 Prior to describing apparatus according to embodiments of the present invention, the principles of the present invention for measuring a variation in the radial force exerted on a tire will first be described with reference to Figs. 1(a) and 1(b).

Fig. 1(a) is illustrative of an equivalent lever L utilized to explain the principles for measurement according to the present invention.

50 Designated at A is a fulcrum, B a point where a force f acts from a tire (spring constant: K), and C a point for measurement of a displacement (force). The point B is spaced from the fulcrum A by a distance l_1 and the point C is spaced from the fulcrum A by a distance l_2 . The lever L is displaced by δ_1 at the point B and by δ_2 at the point C. A relative load acting between the drum and the tire is equivalent to a mass m imposed on the equivalent lever L at the point C. Designated at k is a spring constant of the load imposed on the displacement measuring point C, and at δ_0 is a displacement of the axes of the drum and tire under the relative load at a point B' where the drum and the tire act on each other.

55 It is assumed that weight of the equivalent lever and the relative load applied are respectively zero (in a state of balance).

The force which corresponds to a variation in the radial force (R.F.V) exerted on the tire can be expressed by the following equation:

$$f = K(\delta_0 - \delta_1) \quad (1)$$

The following equations can be given when the lever is in a state of balance or the moments are in equilibrium:

$$l_1 \delta_2 = l_2 \delta_1 \quad (2)$$

$$l_1 K(\delta_0 - \delta_1) = l_2 k \delta_2 \quad (3)$$

From the above two equations, the displacement δ_0 at the point B' can be given by the following equation because the lever L is displaced by δ_2 at the point C:

$$\delta_0 = \frac{K l_1^2 + k l_2^2}{K l_1 l_2} \cdot \delta_2$$

Because of the lever displacement δ_2 at the point C, the lever displacement δ_1 at the point B can be expressed by:

$$\delta_1 = \frac{l_1}{l_2} \delta_2$$

By putting these equations into the equation (1), the force f to be measured can be given by:

$$f = k \frac{l_2^2}{l_1} \delta_2$$

Therefore, the force f can be obtained by seeking the displacement δ_2 of the lever at the point C.

From the equations (2) and (3), the lever displacement δ_1 at the point B can be expressed by the following equation:

$$\delta_1 = \frac{K l_1^2}{K l_1^2 + k l_2^2} \cdot \delta_0 = \frac{1}{1 + \left(\frac{k}{K}\right) \left(\frac{l_2}{l_1}\right)^2} \cdot \delta_0$$

Accordingly, the ratio of δ_1 to δ_0 is as follows:

$$\frac{\delta_1}{\delta_0} = \frac{1}{1 + \left(\frac{k}{K}\right) \left(\frac{l_2}{l_1}\right)^2}$$

Fig. 1(b) shows a curve plotted according to the above equation. By selecting the spring constant k at the point C so as to be sufficiently larger than the spring constant K of the tire ($K \ll k$), the lever displacement δ_1 at the point B approaches zero infinitely, thus allowing a substantially accurate radial force (hereinafter called "R.F.V.") to be obtained.

A measurement obtained on an apparatus according to the present invention will be described with reference to Figs. 2 and 3.

Fig. 2 illustrates for comparison an R.F.V. waveform generated on an apparatus of the present invention and an R.F.V. waveform on a conventional apparatus. Fig. 3 shows correlated peak-peak values of R.F.V. waveforms obtained on both of the apparatus.

From the comparison, it has been found that the waveforms are in substantial conformity with each other and their peak-peak values exhibit a correlation of 0.951. Primary, secondary, third and fourth fundamental harmonics of both measured data exhibit correlations of 0.817, 0.918, 0.976, 0.900, respectively. The apparatus of the present invention has proven capable of giving sufficient values for determining tire uniformity.

The present invention can be put into practice in the following aspects.

According to a first aspect, the movable member comprises a cantilever having one end rigidly secured to a frame and including at the other end the supporting portion supporting the rotatable shaft for rotation with the tire being measured, and also comprises at a suitable position thereof a stress-concentrative member which is mostly deformable when the cantilever is bent in response to a variation in the force imposed radially on the tire.

With the first aspect, a variation in the force imposed radially on the tire can be detected by a strain produced in the stress-concentrative portion of the cantilever.

According to a second aspect, the movable member comprises a movable arm pivotally supported at its

center and having on one end thereof the supporting portion supporting the rotatable shaft for rotation with the tire being measured, whereby the other end of the arm is pivotally movable in a direction opposite to the direction of pivotal movement of said one end in response to a variation in the force imposed radially on the tire.

With the second aspect, a load responsive to a displacement of the other end of the pivotally movable member can be detected by a load cell to determine a variation in the force imposed radially on the tire.

The tire uniformity measuring apparatus according to the present invention can detect a displacement of the movable member as a mechanical displacement, an electrical displacement, or other physical displacements.

Brief description of the drawings

Various other objects, features and advantages of the present invention will be apparent from the following detailed description when considered in connection with the accompanying drawings, in which like reference characters designate like or corresponding parts throughout the several views, and wherein:

Figure 1(a) and (b) are a view illustrative of the principles of measurement according to the present invention and a graph showing a relationship of displacement, respectively;

Fig. 2 is a graph showing measurements for comparison;

Fig. 3 is a graph showing a relationship of correlation between an apparatus of the present invention and a conventional apparatus:

Fig. 4 through 6 show an apparatus according to a first embodiment, Fig. 4 being a side elevational view of the apparatus, Fig. 5 being a front elevational view of the apparatus, Fig. 6 being a block diagram of an electric circuit in the apparatus;

Fig. 7 through 9 illustrate an apparatus according to a second embodiment, Fig. 7 being a side elevational view of the apparatus, Fig. 8 being a front elevational view of the apparatus, Fig. 9 being a circuit diagram of an electric circuit in the apparatus,

and Fig. 10 and 11 show an apparatus according to a third embodiment, Fig. 10 being a side elevational view of the apparatus, Fig. 11 being a front elevational view of the apparatus.

Description of the preferred embodiments

The present invention will be described in detail with reference to embodiments thereof.

An apparatus according to a first embodiment (the first aspect) of the present invention will be described with reference to Figs. 4 through 6.

While the conventional apparatus have detected a reactive force from the support shaft of the tire or the drum, the tire uniformity measuring apparatus according to the first embodiment comprises a movable member 13 having one end rigidly supported for supporting on the other end a tire T rotatably for movement only in a plane constituted jointly by the shafts of the tire and drum, the movable member 13 thus comprising a cantilever serving as a reactive force detector rod.

Adjacent to the fixed end of the reactive force detector rod, there is located a load detecting strain gage serving as a displacement detector means 15 for measuring a reactive force against the tire shaft based on a bending strain produced while the tire shaft is allowed to be displaced slightly.

The reactive force against the tire shaft is properly indicative of an R.F.V. (a variation in the force applied radially to the tire) which constitutes an optimum factor for assessing tire uniformity. Values of the reactive force are measured and recorded to determine nonuniformity of the tire.

The measuring apparatus according to the first embodiment will be described in detail for its construction, operation and advantages.

As shown in Fig. 4, a load applying means 14 for imposing a relative load on a tire and a drum comprises a table B2 mounted on a pair of pantograph-shaped jacks PJK supported on a machine base or frame MB. An electric motor M and a rotatable drum 11 drivable thereby through a chain C1 mounted on the table B2. A tire T is disposed such that its axis is vertically aligned with the axis of the rotatable drum 11. The pantograph-shaped jack PJK has a drive screw DS which extends through a bearing BS and which has a gear G1 rotatable by a chain C2 which extends around a gear G2 connected to a handle HL rotatably supported on a support post MH and disposed exteriorly of the frame. Thus, the jacks PJK are driven by rotation of the handle HL to move the drum 11 vertically to impose a predetermined load on the tire T being measured.

The displacement detector means 15 comprises strain gages SG attached to a stress-concentrative portion adjacent to the fixed end of a cantilever beam 17 which constitutes the movable member 13 having on one end a tire holder 12 for supporting the tire T. The tire T is attached to the tire holder 12 for free rotation.

The beam 17 has the other end rigidly fixed to the support post MH. The strain gages SG are attached to opposite sides of a vertically constricted portion of the beam 17 located adjacent to the fixed end thereof, the beam 17 being bendable in a plane defined jointly by the shafts of the drum and tire. When the beam 17 is bent under a force applied radially to the tire T mounted on the distal end of the beam 17, the strain gages SG detect the bending stress produced in the beam 17 as a bending strain to derive a bending force or load. The constricted portion of the beam 17 should be flexible enough to allow a load acting on the distal end thereof to be detected and also should be of a sufficient mechanical strength.

With the foregoing arrangement, the tire T is given a load corresponding to an actual load which the tire T would be subjected to when running on a road by manually moving the drum 11 vertically through the handle HL, and at the same time reactive forces applied against the shaft of the tire while the latter is rotated by the drum 11 can be detected by the strain gages SG as bending forces imposed on the beam 17.

An indicator means 16, as shown in Fig. 5, is housed in an electric circuit container box mounted on the support post MH at an upper portion thereof which is sufficiently rigid. The container box has a front panel FP on which are mounted a load variation recorder RD, a load indication meter MT, a switch SW, and a level adjustment dial LA.

The indicator means 16 comprises an electric circuit as illustrated in Fig. 6. A bridge circuit BC of the strain gages SG wired in full bridge form is energized by a voltage applied by a power supply V to generate a signal which is amplified by an amplifier AM. An amplified signal is indicated on the load indication meter MT, which is graduated in units of Kg. The operator can establish a desired load imposed on the tire while observing indications on the meter MT. The amplified signal is supplied to an arithmetic circuit OA wherein the signal is added to a signal generated by a load setting circuit RC. Arithmetic operation is performed to subtract a signal to be indicated on the meter MT, thereby obtaining only a signal indicative of a variation in the load applied to the tire T while being revolved. The signal thus obtained is supplied to the load variation recorder RD in which load variations are recorded on recording paper.

Thus, an R.F.V. waveform can be displayed on the recorder RD. With electric detection of load variations, the apparatus according to the first embodiment is compact in size and practically advantageous.

A tire uniformity measuring apparatus according to a second embodiment (the second aspect) will be described with reference to Figs. 7 through 9.

The tire uniformity measuring apparatus of the second embodiment comprises a movable member 23 serving as a balance rod pivotally supported centrally on a machine base or frame and movable only in a plane defined jointly by the axes of a tire T and a drum, the tire T being mounted on one end of the movable member 23, and a load cell located at the other end of the movable member 23, so that the load cell can measure reactive forces applied against the shaft of the tire while the latter is allowed to move slightly. The reactive force against the tire shaft is properly indicative of an R.F.V. (a variation in the force applied radially to the tire) which is an optimum factor for assessing tire uniformity. Values of the reactive force are measured and recorded to determine nonuniformity of the tire.

The measuring apparatus according to the second embodiment will be described in detail for its construction, operation and advantages.

A load applying means 24 comprises, as illustrated in Fig. 7, a reversed L-shaped support BL having plates SL1, SL2 and a rigid table B3 sliding on the plates SL1, SL2. The table B3, as shown in Fig. 8, has on one end thereof a drum shaft journaled in a bearing BE, the drum shaft having on opposite ends thereof bearings TB1 rolling on the plates SL1. A motor M is mounted on the table B3 for driving a drum 21 having a diameter of 300 mm through a chain C2 disposed around a motor gear G3 and a driven drum gear G4. The gear ratio between the gears and RPM of the motor M are selected such that the tire T will be driven to rotate at a speed of 5 revolutions per minute. The table B3 has on the other end a pair of bearings TB2 movable on the plates SL2. A jack JK is connected to the lower end of the table B2 at its center and is actuatable by a drive screw DS extending through a bearing on the frame MB to move the lower end of the table B3 back and forth. The jack JK is actuatable by rotation of the handle HL journaled on a support post MH and disposed exteriorly of the frame through a chain C3 extending around gears G5, G6. The load applying means 24 thus constructed moves the drum 21 upwardly or downwardly.

A displacement detector means 25 comprises a load cell LC for detecting displacements of the balance lever 23 supporting the tire T as load variations.

The tire T being measured is freely rotatably mounted on a tire holder 22 on one end of the balance lever 23 with the other end thereof being free. A switch 27 for generating primary values upon rotation of the tire T is disposed adjacent to the tire holder 22. The balance lever 23 is centrally pivotally supported by a bearing SP fixed to the support post MH. The free end of the balance lever 23 is flat and held against a top end of the load cell LC disposed on the support post MH at an upper portion thereof. The axes of the tire and drum are in vertical alignment with each other.

By manually moving the drum 21 vertically with the handle HL, the tire T being measured is given a load corresponding to an actual load which the tire T would undergo while running on a road. The load cell LC can detect reactive forces produced against the shaft of the tire T as the latter is driven to rotate by the drum 21 driven by the motor M.

As illustrated in Fig. 8, an indicator means 26 is housed in an electric circuit container mounted on the support post MH at an upper portion thereof which is sufficiently rigid. The container box has a front panel FP mounting thereon a recorder 37, a meter 38, a switch 39, and a level adjustment dial 40.

The indicator means 26 comprises an electric circuit as shown in Fig. 9. The circuit includes a power supply comprising the switch 39 and a voltage generating circuit 420 having a transformer 400 and a voltage regulator 41. The circuit is supplied with inputs which comprise an output from a bridge circuit 42 having strain gages R_1 - R_4 connected in full bridge form on stress rods in the load cell LC, and an output from the primary pulse generation switch 27. The electrical circuit shown in Fig. 9 except the bridge circuit 42 and the primary pulse generation switch 27 is accommodated in the container box.

The output from the bridge circuit 42 in the load cell LC is supplied via terminals 2, 3, protective resistors R_5 , R_6 to signal amplifier 44 in a signal amplifying circuit 43. The signal amplifying circuit 43 comprises the signal amplifier 44, a gain adjuster 45 including resistors R_7 , R_8 , and a zero adjuster 46 having a variable resistor R_9 . The amplified signals from the signal amplifier 44 are supplied to the meter sensitivity setting circuit 47 and to circuit 48. An amplified signal from the signal amplifier 44 is supplied via a protective resistor R_{10} and a meter sensitivity setting circuit 47 comprising a variable resistor R_{11} to the indication meter 38.

The indication meter 38 is graduated in Kg for indicating the magnitude of a signal as calibrated by the zero adjuster 46 and the gain adjuster 45 in the signal amplifying circuit 43. The operator, while observing the indication on the meter, can move the drum 21 upwardly with the handle HL to impose on the tire T being measured a load corresponding to an actual load which would act on the tire T while running on a road.

The amplified signal from the signal amplifier 44 is also supplied via a protective resistor R_{12} to a circuit 48 for separating a signal component for load variations which comprises a protective resistor R_{13} , a protective capacitor C_1 , an adder 49, and a protective resistor R_{14} . The adder 49 is supplied with a signal from a level adjustment dial 40 comprising a variable resistor R_{16} via a resistor R_{15} and also supplied with a signal from the primary pulse generation switch 27 via a gain adjuster 50 comprising resistors R_{17} through R_{20} . The level adjustment dial 40 separates a load signal generated by the bridge circuit 42 into a signal component for a load variation produced when the tire rotates and a signal component for the initially applied load by subtracting a voltage indicative of the initially applied load from a signal voltage from the signal amplifier 44 in the signal amplifying circuit 43 to generate a signal voltage indicative of the load variation.

The primary pulse generation switch 27 comprises a leaf spring for mechanically detecting one revolution of the tire T. A pulse produced when the switch 27 is closed and opened is determined in magnitude by the gain adjuster 50 and added to the main signal in the adder 49. A signal from the adder 49 is fed through a meter protecting circuit 51 comprising a resistor R_{21} and diodes D_1 , D_2 to drive the recorder 37.

Thus, a load or force imposed radially on the tire T while revolving is measured by the load cell LC, which produces an output signal supplied to the signal amplifying circuit 43 and the separation circuit 48, which generates a signal indicative only of an R.F.V. (a load variation applied radially to the tire) written by a pen on a sheet of chart paper in the recorder 37. Since the waveform recorded on the chart paper includes one pulsed signal added to the substantive signal per revolution of the tire, it can be ascertained what part of the tire has the greatest R.F.V.

The apparatus according to the second embodiment is advantageous in that it can measure variations in the force imposed radially on the tire stably with precision in a condition approximating an actual running condition.

The apparatus can be handled and maintained with ease, is small in size as it takes up a small space with the drum and the tire arranged vertically relatively to each other, and is light in weight and inexpensive to construct.

The apparatus is also advantageous in that the movable member comprises a balance lever and the displacement detector means comprises a load cell used in combination with the balance lever for making stabler measurement than the first embodiment.

With the apparatus according to the present invention, the tire is rotated at a speed of 5 revolutions per minute which is much smaller than the speed of rotation of tires in conventional apparatus, and hence no provision is necessary to increase the rigidity of the apparatus. The drum is 300 mm in diameter, rendering the apparatus small in size and light in weight.

A tire uniformity measuring apparatus according to a third embodiment (the second aspect) will be described with reference to Figs. 10 and 11, the apparatus constituting a modification of the apparatus of the second embodiment.

While the tire and the drum are arranged in vertical alignment with respect to each other according to the second embodiment, they are aligned horizontally with respect to each other according to the third embodiment in order to place the tire being tested in a lowered position for easier operation of the apparatus.

The measuring apparatus of the third embodiment will be described for its construction, operation and advantages.

A load applying means 34 comprises, as shown in Fig. 10 and 11, a slide surface 53 on a machine base or frame MB for allowing a slide frame 52 of a U-shaped cross section to slide smoothly thereon, and a guide 54 secured to the frame MB for guiding a slide frame 52 to slide in a fixed direction. A drum 31 is mounted on the slide frame 52 so as to be movable horizontally into pressed engagement with the tire T.

As shown in Fig. 10 and 11, the slide frame 52 which is rigid supports at a front end thereof a drum shaft 55 through a bearing and at a rear end thereof a motor M. The drum 31 is driven by the motor M through a chain 56 travelling around drive and driven gears 57, 58. The slide frame 52 has on a side wall thereof a female screw 59 through which threadedly extends a drive screw 60. By turning a manual handle HL attached to the drive screw 60 extending through a support post MH secured to the frame MB, the slide frame 52 is moved back and forth along the slide surface 53 and the guide 54.

The load applying means 34 thus constructed moves the drum 31 back and forth.

A displacement detector means 35 comprises, as in the second embodiment, a load cell LC for detecting a load variation a displacement of a balance lever 23 for holding a tire T.

As the drum 31 is disposed in horizontally confronting relation to the tire T being measured, the balance lever serving as a movable member is differently positioned and hence the load cell LC is disposed horizontally with respect to the support post MH. Other structural details are the same as those of the foregoing embodiment, and will not be described.

An indicator means 36 is of the same construction as that of the second embodiment, and hence will not be described.

When the drum 31 is manually moved horizontally with the handle HL, the tire T being measured is given a load corresponding to an actual load to which the tire T would be subjected while running on a road. The load cell LC detects reactive forces acting against the tire shaft when the tire is caused to rotate by the drum 31 driven by the motor M.

The indicator means 36 is responsive to signals detected by the load cell LC for recording variations in the force imposed radially on the tire in a recorder 37 wherein the variations are plotted by a pen on a sheet of chart paper.

The apparatus according to the third embodiment has the same advantages as those of the apparatus of the second embodiment and additionally can be operated with ease as the tire and the drum confront each other horizontally.

It should be understood that the present invention should not be limited to the above embodiments, and many changes in design and added modifications may be made without departing from the spirit of the appended claims.

Claims

1. A tire uniformity measuring apparatus comprising

- a) a drum (11, 21, 31) contacting a tire (T) to be measured;
 - b) a rotatable shaft (12, 22, 32) having an attachment for securing the tire in position;
 - c) a drive source (M);
 - d) a load applying means (14, 24, 34) for applying a predetermined load directly on the tire by a movement of said drum for changing an interaxial distance between said drum and rotatable shaft;
 - e) a movable member (13, 23) being movable about a fulcrum being rigidly supported on the measuring apparatus in response to a force acting between said drum (11, 21, 31) and the tire (T) to be measured;
 - f) a displacement detecting means (15, 25, 35) for detecting a displacement of said movable member dependent on a variation in a load applied radially to the tire while the latter is rotated by said drum and
 - g) display means (16, 26, 36) for displaying the variation in the load applied radially to the tire in response to the displacement of said movable member,
- characterized** in that
- h) said movable member (13, 23) has a part rotatably and coaxially supporting said rotatable shaft (12, 22, 32),
 - i) said drum (11, 21, 31) is rotatively driven by the drive source (M) and rotates the tire and that

j) the longitudinal axis of said movable member (13, 23, 33) is disposed in parallel with the rotation axis of the drum.

- 5 2. A tire uniformity measuring apparatus according to claim 1, wherein said movable member (13) comprises a cantilever (17) having one end rigidly secured to a frame (MB, MH) and including at the other end said supporting portion supporting said rotatable shaft (12) for rotation with the tire (T) being measured, and also comprises at a suitable position a stress-concentrative member (SG) which is mostly deformable when said cantilever (17) is bent in response to a variation in the force imposed radially on the tire.
- 10 3. A tire uniformity measuring apparatus according to claim 1, wherein said movable member (23) comprises a pivot arm pivotably supported at its center and having on one end thereof said supporting portion supporting said rotatable shaft (22) for rotation with the tire (T) being measured, whereby the other end of said arm is angularly movable in a direction opposite to the direction of angular movement of said one end in response to a variation in the force imposed radially on the tire.
- 15 4. A tire uniformity measuring apparatus according to claim 1, wherein said load applying means (14, 24, 34) moves said drum (11, 21, 31) in order to apply the predetermined load to the tire (T).
- 20 5. A tire uniformity measuring apparatus according to claim 4, wherein said drum (11, 21) is provided under the tire (T), in order to mount the tire on said drum.
6. A tire uniformity measuring apparatus according to claim 4, wherein said drum (31) is provided laterally to the tire (T).
- 25 7. A tire uniformity measuring apparatus according to claim 5, wherein said drum (11, 31) rotatably mounts on a movable member (B2, B3) of said load applying means.
8. A tire uniformity measuring apparatus according to claim 7, wherein said movable member comprises a plate member (B2) rotatably supporting said drum (11) and jack means (PJK) for changing the position of said plate member in the vertical direction, fixed to said plate member at one end thereof.
- 30 9. A tire uniformity measuring apparatus according to claim 7, wherein said movable member comprises a table (B3) having two bearings (TB1, TB2) at both ends thereof, and a frame (BL) having horizontal guide rail (SL2) and perpendicular guide rail (SL1) on which said bearings of said table is rolled.
- 35 10. A tire uniformity measuring apparatus according to claim 2, wherein said detecting means (16) comprises a strain gauge (SG) attached on a suitable position concentratively stressed.
11. A tire uniformity measuring apparatus according to claim 3, wherein said detecting means (26) comprises a load cell (LC), for detecting the load, provided at a position opposed to the other end of said pivot arm.

Patentansprüche

1. Vorrichtung zum Messen der Gleichförmigkeit von Reifen mit
 - 45 a) einer Trommel (11, 21, 31), die mit einem zu messenden Reifen (T) in Berührung steht;
 - b) einer Drehwelle (12, 22, 32), die eine Halterung zum Befestigen des Reifens in der vorgeschriebenen Position besitzt;
 - c) einer Antriebsquelle (M);
 - d) einer Belastungseinrichtung (14, 24, 34) zum Beaufschlagen des Reifens mit einer vorgegebenen Last durch eine Bewegung der Trommel zum Ändern des Achsabstandes zwischen der Trommel und der Drehwelle;
 - 50 e) einem beweglichen Element (13, 23), das abhängig von einer zwischen der Trommel (11, 21, 31) und dem zu messenden Reifen (T) wirkenden Kraft um einen an der Meßvorrichtung steif abgestützten Drehpunkt bewegbar ist,
 - 55 f) einer Verschiebungsmeßvorrichtung (15, 25, 35) zum Erfassen einer Verschiebung des beweglichen Elementes in Abhängigkeit von einer Änderung der radial auf den Reifen aufgetragenen Last während der Reifen durch die Trommel gedreht wird und
 - g) einer Anzeigeeinrichtung (16, 26, 36) zum Anzeigen der Änderung der radial auf den Reifen aufge-

brachten Last in Abhängigkeit von der Verschiebung des beweglichen Elementes dadurch **gekennzeichnet**, daß

- h) das bewegliche Element (13, 23) einen Teil besitzt, der drehbar und koaxial die Drehwelle (12, 22, 32) trägt,
 - 5 i) die Trommel (11, 21, 31) durch die Antriebsquelle (M) gedreht wird und den Reifen dreht und
 - j) die Längsachse des beweglichen Elementes (13, 23, 33) parallel zur Drehachse der Trommel angeordnet ist.
2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das bewegliche Element (13) einen Ausleger (17) enthält, dessen eines Ende fest an einem Rahmen (MB, MH) eingespannt ist und dessen anderes Ende den Tragteil umfaßt, der die Drehwelle (12) für die Rotation mit dem zu messenden Reifen (T) trägt, und außerdem an einer geeigneten Stelle ein Teil (SG) mit konzentrierter Beanspruchung enthält, das bei einer Biegung des Auslegers (17) abhängig von einer Änderung der radial auf den Reifen ausgeübten Kraft am meisten verformbar ist.
 - 10 3. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das bewegliche Element (23) einen Schwenkarm enthält, der in der Mitte drehbar gelagert ist und an einem Ende den Tragteil aufweist, der die Drehwelle (22) für die Rotation mit dem zu messenden Reifen (T) trägt, während das zweite Ende des Schwenkarms abhängig von einer Änderung der radial auf den Reifen ausgeübten Kraft winkelförmig in einer Richtung entgegengesetzt zur Richtung der winkelförmigen Bewegung des ersten Endes bewegbar ist.
 - 15 4. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Belastungseinrichtung (14, 24, 34) die Trommel (11, 21, 31) verschiebt, um den Reifen (T) mit der vorgegebenen Last zu beaufschlagen.
 - 20 5. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß die Trommel (11, 21) unterhalb des Reifens (T) vorgesehen ist, um den Reifen auf die Trommel aufzusetzen.
 6. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß die Trommel (31) seitlich des Reifens (T) angeordnet ist.
 - 25 7. Vorrichtung nach Anspruch 5, dadurch gekennzeichnet, daß die Trommel (11, 31) drehbar auf einem verschiebbaren Teil (B2, B3) der Belastungseinrichtung gelagert ist.
 - 30 8. Vorrichtung nach Anspruch 7, dadurch gekennzeichnet, daß das verschiebbare Teil eine Platte (B2) umfaßt, die drehbar die Trommel (11) trägt sowie eine Hebeeinrichtung (PJK) zum Ändern der Position der Platte in vertikaler Richtung, die mit einem Ende an der Platte befestigt ist.
 - 35 9. Vorrichtung nach Anspruch 7, dadurch gekennzeichnet, daß das verschiebbare Teil einen Tisch (B3) mit zwei Lagern (TB1, TB2) an beiden Enden enthält sowie einen Rahmen (BL) mit einer horizontalen Führungsschiene (SL2) und einer senkrechten Führungsschiene (SL1), auf denen die Lager des Tisches abrollen.
 - 40 10. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die Meßeinrichtung (16) ein Dehnungselement (SG) enthält, das an geeigneter Stelle, an der eine konzentrierte Beanspruchung vorliegt, angebracht ist.
 - 45 11. Vorrichtung nach Anspruch 3, dadurch gekennzeichnet, daß die Meßeinrichtung (26) eine Kraftmeßdose (LC) zum Erfassen der Last enthält, die an einer Stelle vorgesehen ist, die dem zweiten Ende des Schwenkarms gegenüberliegt.

Revendications

1. Un appareil de mesure de l'uniformité de pneumatiques, comprenant :
 - 55 a) un tambour (11,21,31) venant en contact avec un pneumatique (T) à mesurer ;
 - b) un arbre tournant (12,22,32) comportant un élément de fixation destiné à fixer le pneumatique en position;
 - c) une source d'énergie d'entraînement (M);

- d) un dispositif d'application de charge (14,24,34) destiné à appliquer une charge prédéterminée directement au pneumatique par un déplacement du tambour pour modifier une distance entre les axes du tambour et de l'arbre tournant ;
- 5 e) un élément mobile (13, 23) qui peut se déplacer autour d'un point pivot supporté rigidement par l'appareil de mesure, sous l'effet d'une force agissant entre le tambour (11,21,31) et le pneumatique (T) à mesurer ;
- f) des moyens de détection de déplacement (15,25,35) destinée à détecter un déplacement de l'élément mobile sous l'effet d'une variation d'une charge appliquée radialement au pneumatique, pendant que ce dernier est mis en rotation par le tambour ; et
- 10 g) des moyens de visualisation (16,26,36) destinés à visualiser la variation de la charge appliquée radialement au pneumatique, en réponse au déplacement de l'élément mobile,
- caractérisé** en ce que
- h) l'élément mobile (13,23) comporte une partie qui supporte l'arbre tournant (12,22,32) de façon tournante et coaxiale,
- 15 i) le tambour (11,21,31) est entraîné en rotation par la source d'énergie d'entraînement (M) et il fait tourner le pneumatique, et en ce que
- j) l'axe longitudinal de l'élément mobile (13,23,33) est parallèle à l'axe de rotation du tambour.
2. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 1, dans lequel l'élément mobile (13) comprend un élément en porte-à-faux (17) dont une extrémité est fixée de façon rigide à un châssis (MB, MH) et qui comporte à l'autre extrémité la partie de support supportant l'arbre tournant (12) de façon qu'il tourne avec le pneumatique (T) à mesurer, et il comprend également, en une position appropriée, un élément de concentration des efforts (SG) qui se déforme le plus fortement lorsque l'élément en porte-à-faux (17) est courbé sous l'effet d'une variation de la force appliquée radialement au pneumatique.
- 20 25
3. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 1, dans lequel l'élément mobile (23) comprend un bras pivotant qui est supporté de façon pivotante en son centre et qui comporte à une première extrémité la partie de support supportant l'arbre tournant (22) pour permettre sa rotation avec le pneumatique (T) à mesurer, tandis que la seconde extrémité de ce bras accomplit un mouvement angulaire dans une direction opposée à la direction du mouvement angulaire de la première extrémité, sous l'effet d'une variation de la force appliquée radialement au pneumatique.
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4. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 1, dans lequel le dispositif d'application de charge (14, 24, 34) déplace le tambour (11, 21, 31) dans le but d'appliquer la charge prédéterminée au pneumatique (T).
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5. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 4, dans lequel le tambour (11, 21) est placé au-dessous du pneumatique (T), de façon à permettre le montage du pneumatique au-dessus du tambour.
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6. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 4, dans lequel le tambour (31) est placé latéralement par rapport au pneumatique (T).
7. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 5, dans lequel le tambour (11, 31) est monté de façon tournante sur un élément mobile (B2, B3) du dispositif d'application de charge.
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8. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 7, dans lequel l'élément mobile comprend une plaque (B2) qui supporte le tambour (11) de façon tournante, et un dispositif à vérins (PJK) destiné à modifier la position de la plaque dans la direction verticale, qui est fixé à une extrémité de la plaque.
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9. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 7, dans lequel l'élément mobile comprend un plateau (B3) comportant deux paliers (TB1, TB2) à ses deux extrémités, et un rail de guidage horizontal (SL2) et un rail de guidage perpendiculaire (SL1) sur lesquels roulent les paliers du plateau.
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10. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 2, dans lequel les moyens de détection (16) comprennent un extensomètre (SG) qui est fixé en une position appropriée dans laquelle

les efforts sont concentrés.

- 5 11. Un appareil de mesure de l'uniformité de pneumatiques selon la revendication 3, dans lequel les moyens de détection (26) comprennent une cellule dynamométrique (LC), destinée à détecter la charge, qui est placée face à la seconde extrémité du bras pivotant.

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FIG. 1(a)

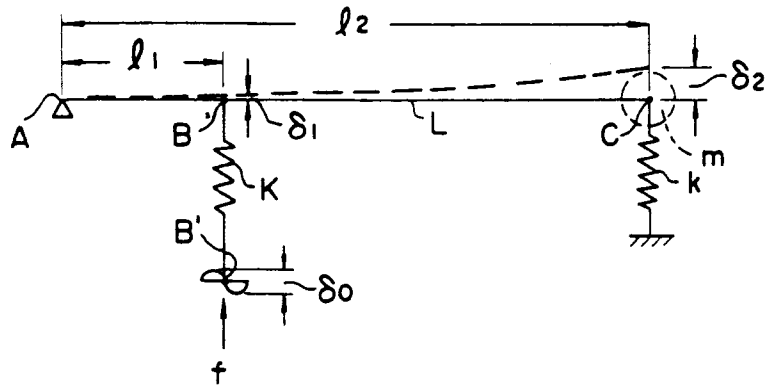


FIG. 1(b)

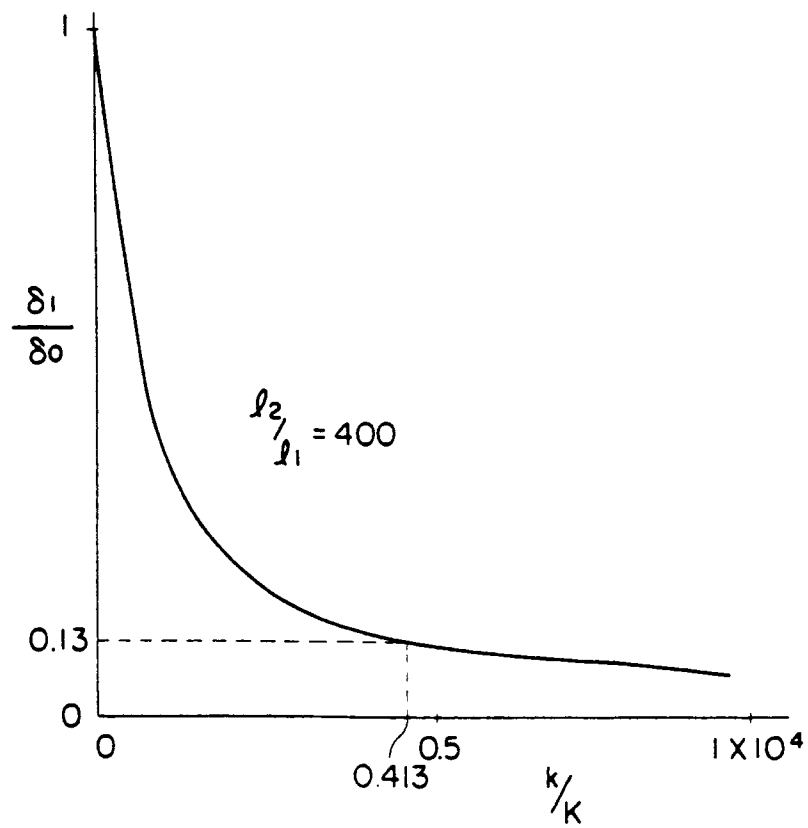


FIG. 2

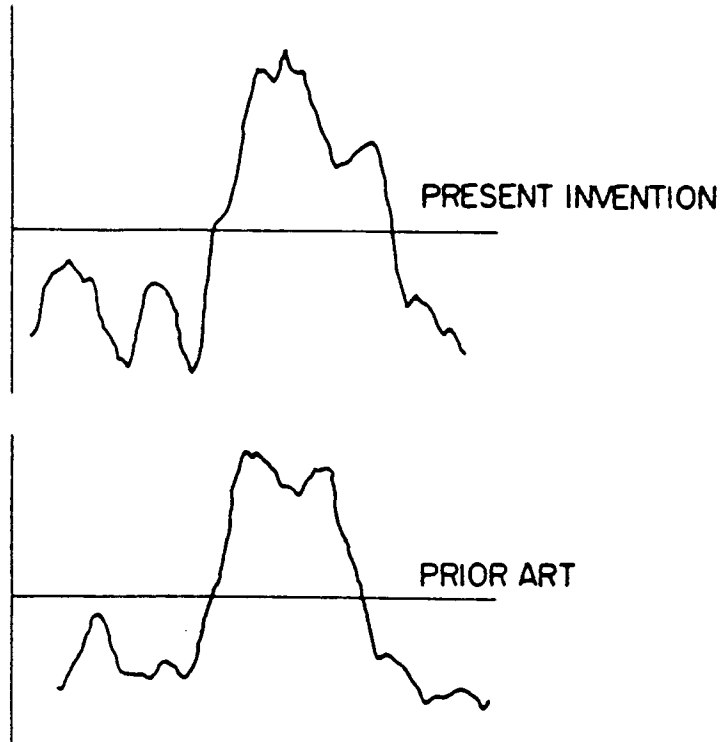


FIG. 3

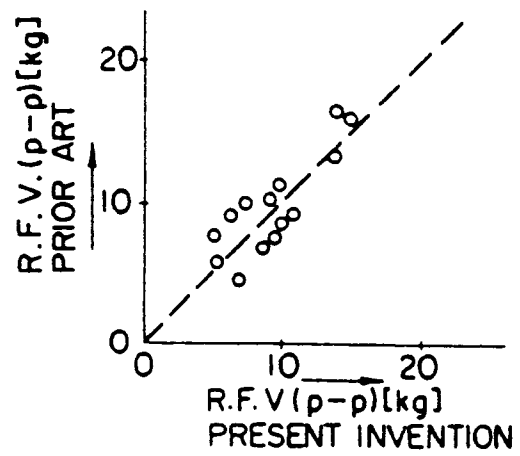


FIG. 4

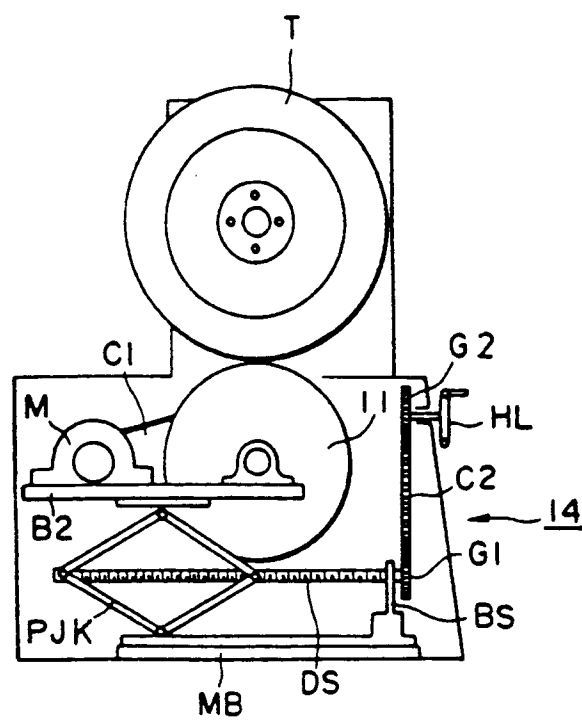


FIG. 5

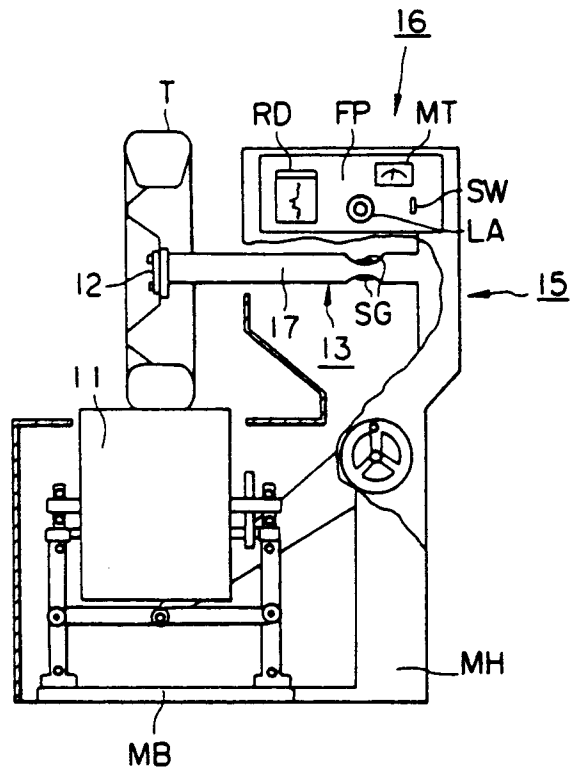


FIG. 6

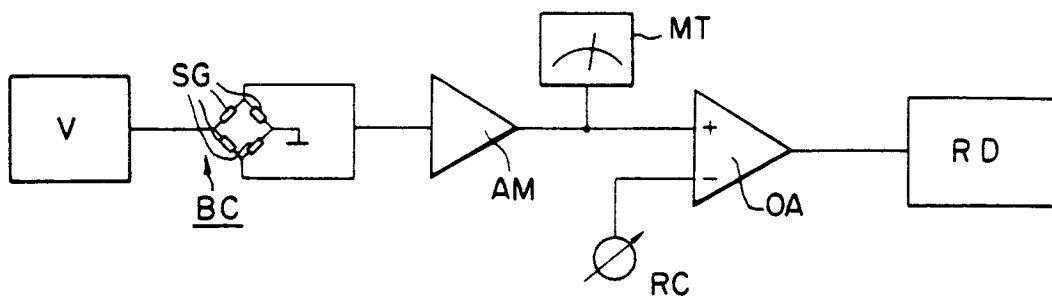


FIG. 7

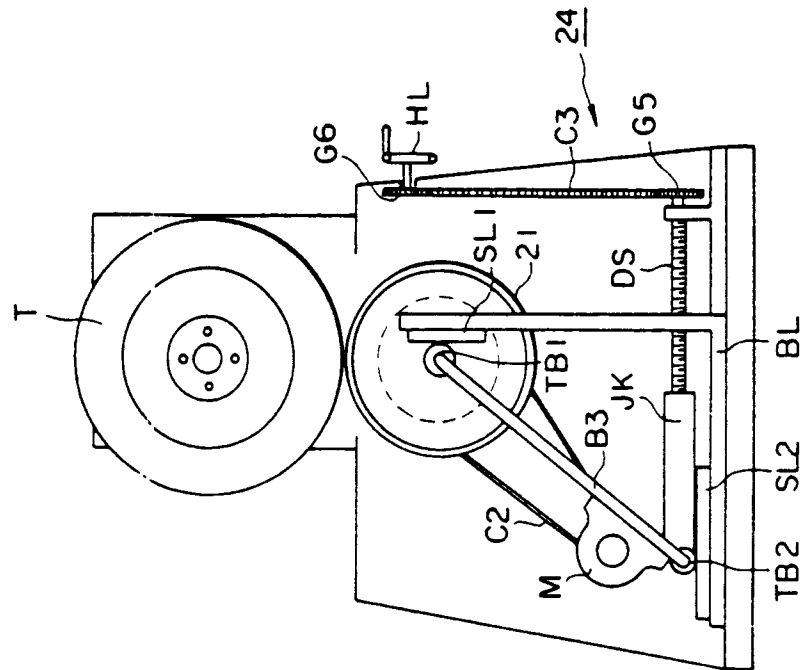
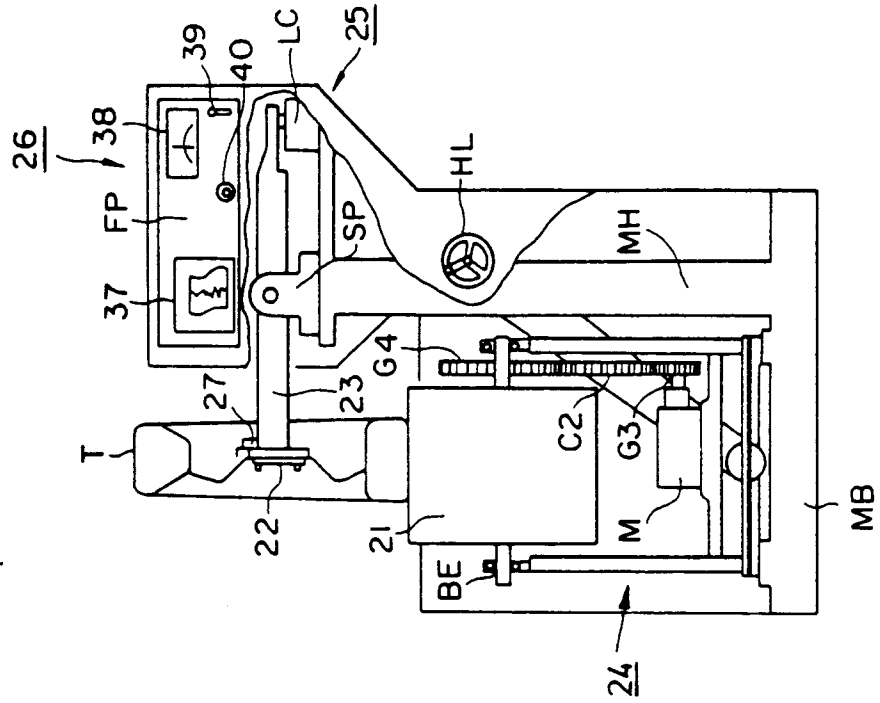


FIG. 8



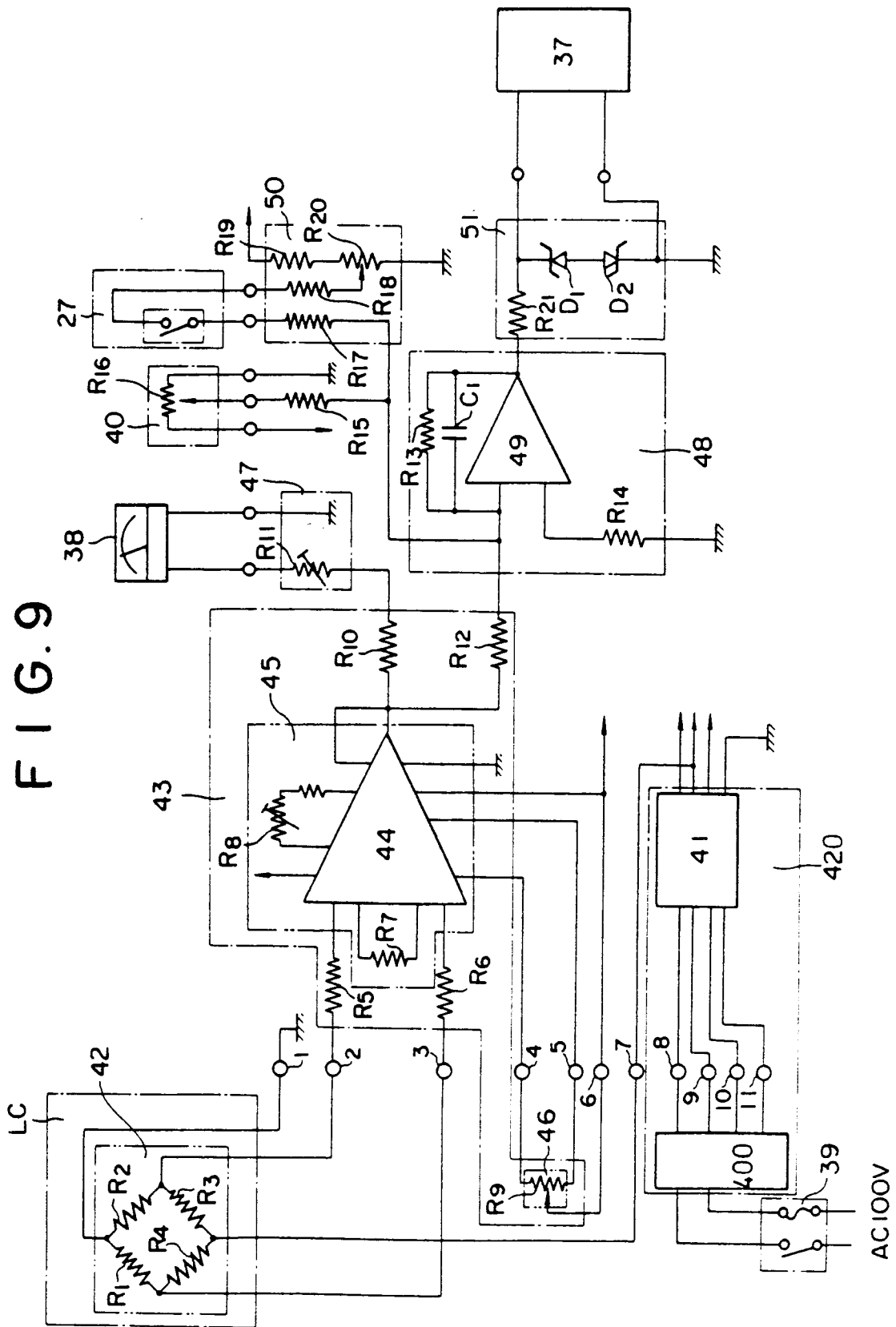


FIG. 10

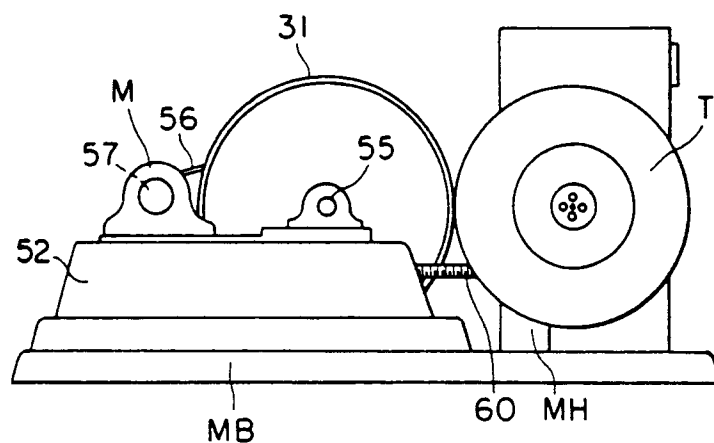


FIG. 11

